



# **Civil UAV Applications in Japan and Related Safety & Certification**

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Report Documentation Page			Form Approved OMB No. 0704-0188		
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE <b>02 SEP 2003</b>		2. REPORT TYPE <b>N/A</b>		3. DATES COVERED <b>-</b>	
4. TITLE AND SUBTITLE <b>Civil UAV Applications in Japan and Related Safety &amp; Certification</b>				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>Aeronautic Operations YAMAHA MOTOR CO., LTD., Shizuoka, Japan</b>				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release, distribution unlimited</b>					
13. SUPPLEMENTARY NOTES <b>See also ADM001676, UAV 2002 Conference &amp; Exhibition., The original document contains color images.</b>					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>UU</b>	18. NUMBER OF PAGES <b>24</b>	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			

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6. Conclusion



## Introduction

**1500 Unmanned Helicopters** are used for civil applications in Japan.

1. Reasons why an unmanned Helicopter was developed and how it became popular in Japan.
2. What kind of certifications are applied in agricultural use of unmanned helicopters ?
3. Recently developed autonomous unmanned helicopter extends civil applications
4. Background and Objectives of the Japanese Working Group dealing with certification.

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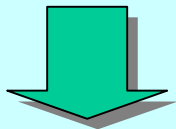
## Background and Development

### of the Unmanned Helicopter agricultural use

#### Chemical Spraying for rice field.

In 1958, 'Manned Helicopter' use started.

(In 1992, 27 % of rice fields sprayed by 'Manned Helicopter'.)

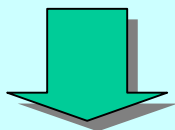


Complaint of Residents.

Necessary for Farmers.

In 1982, YAMAHA started to develop Unmanned Helicopter.

In 1990, YAMAHA put it on the market.



Other companies joined this market.

In 2000, 24 % of rice fields sprayed by 'Manned Helicopter'

10 % by Unmanned Helicopter.



## Industrial Use of Unmanned Helicopter for agricultural use

YAMAHA



R50



RMAX

	R50	RMAX
Main Rotor Diameter(mm)	3,070	3,115
Tail Rotor Diameter(mm)	520	545
Overall Length(mm)	3,580	3,630
Overall Height(mm)	1,080	1,080
Overall Width(mm)	700	720
Empty Weight(kg)	47	64
Payload(kg)	20	30
Engine		
Displacement(cc)	98	246
Category	Water Cooled 2 Stroke	
Maximum Output(KW)	8.8	15.4



## Industrial Use of Unmanned Helicopter for agricultural use

YANMAR



YH300

Fuji Heavy Industry



RPH2

KAWADA



RoboCopter

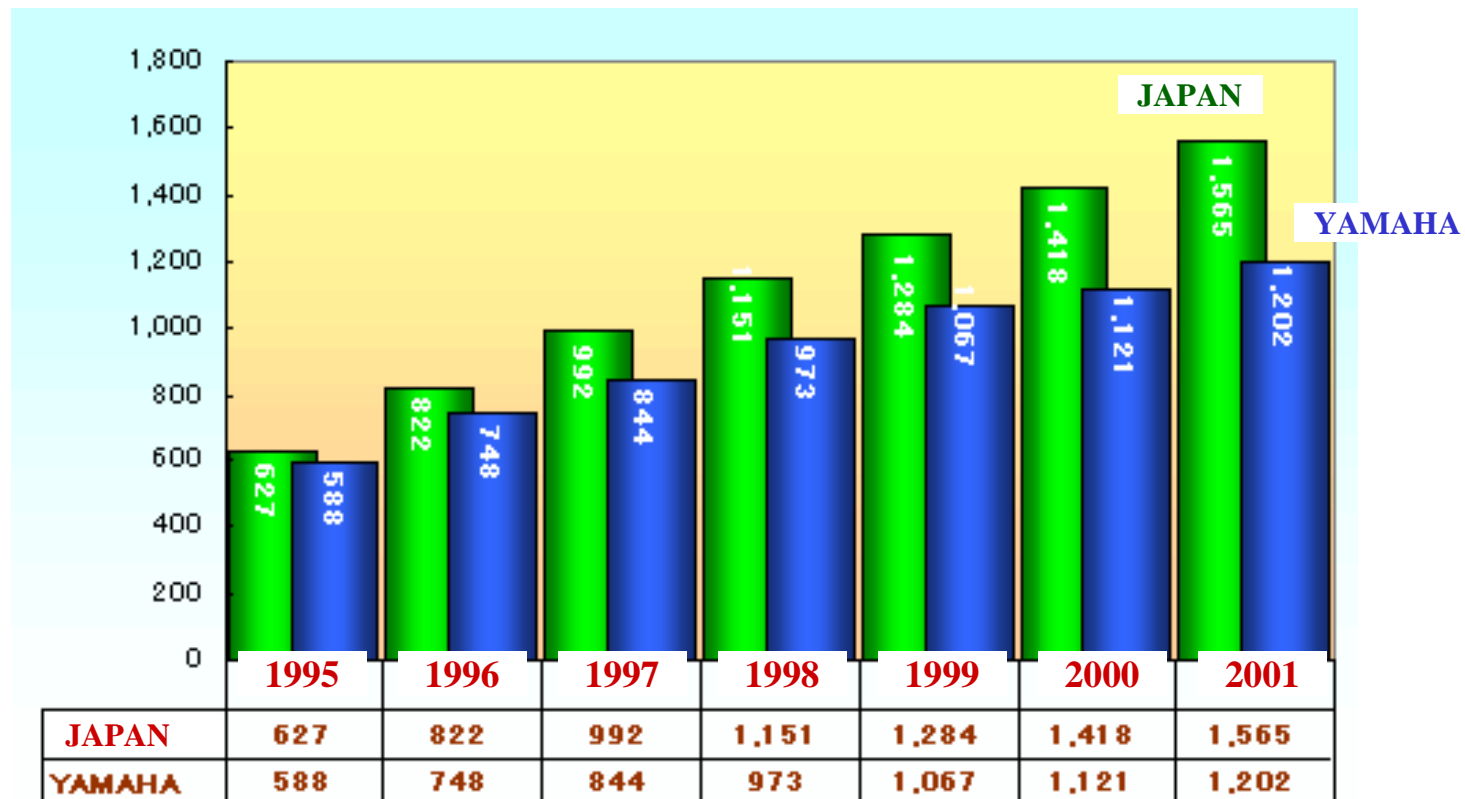
	YH300	RPH2	Robo Copter
Main Rotor Diameter(mm)	3,38	4,800	8,180
Overall Height(mm)	1,150	1,750	2,650
Empty Weight(kg)	58	230	500
Payload(kg)	30	100	294
Engine			
Maximum Output(KW)	14.7	61.4	124





## Registered Number of Unmanned Helicopter for agricultural use

YAMAHA maintains 80 % share .



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## *Industrial Use of Unmanned Helicopter for agricultural use*

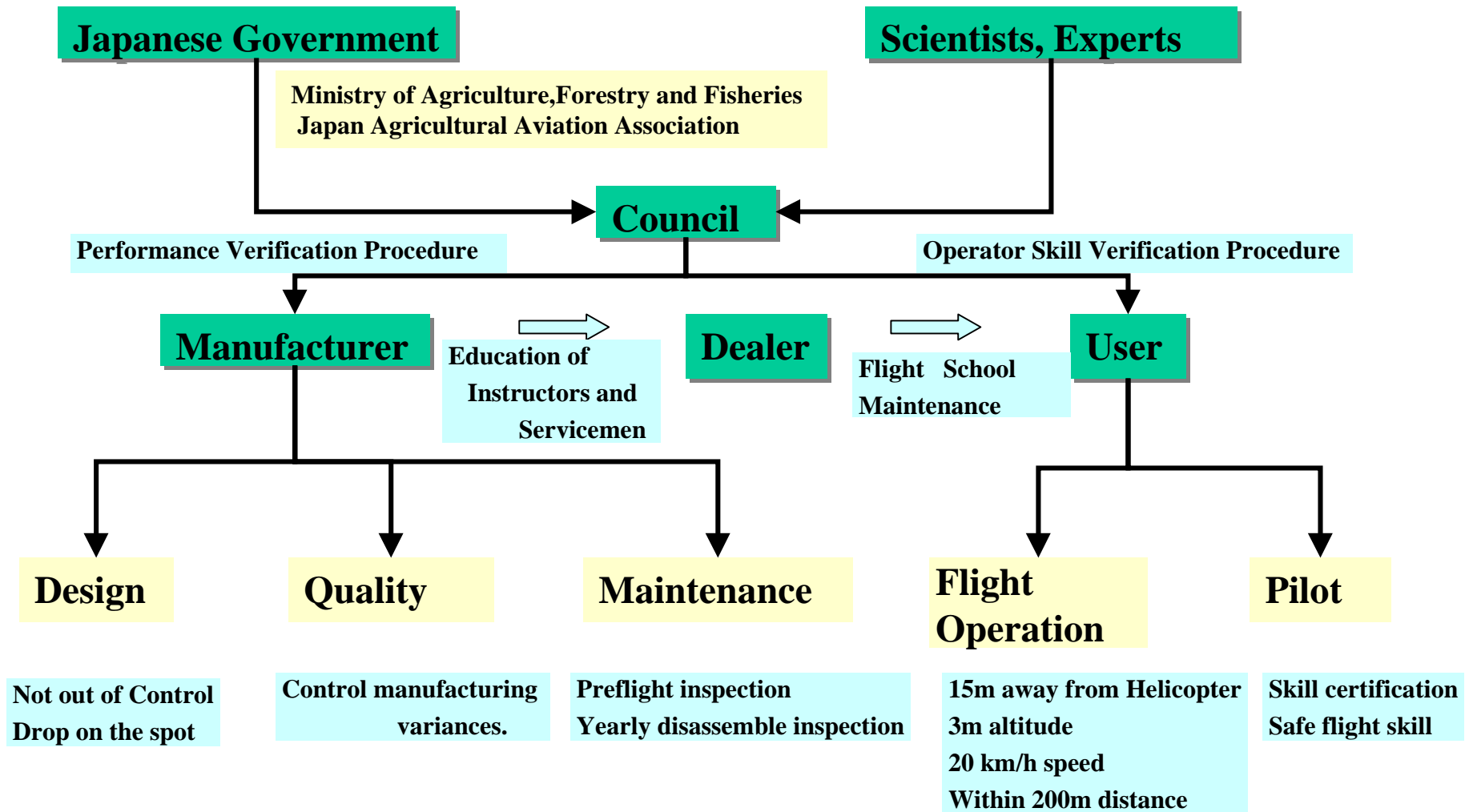
### **Safety Operations for Chemical Spraying**

1. No crew on the Helicopter
2. Low speed (20 km/h) and Low altitude( 3-5m)
3. Safety Standard by Japanese Government  
Structure, Flight Performance, Inspection, Maintenance  
Operator License ,Operator Registration System

### **YAMAHA Safety First Policy**

1. Various Tests for reliability and durability
2. Maintenance Training for Serviceman
3. Periodical Maintenance

## Outline of Operational Safety in Agricultural Applications



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## *Background and Development of Autonomous Helicopter*

Japan is famous for volcanoes and earthquakes.

In 1990 - Unzen volcano erupted.

In 1995 - the Great Hanshin Earthquake

In 1997, YAMAHA started to develop

Autonomous Unmanned Helicopter for disaster use.

In 1999, YAMAHA established a prototype model.

In 2000, Observation role at Mt.Usu

In 2001, Observation role on Miyake-jima Island



**Observation Flight at Mt.Usu**



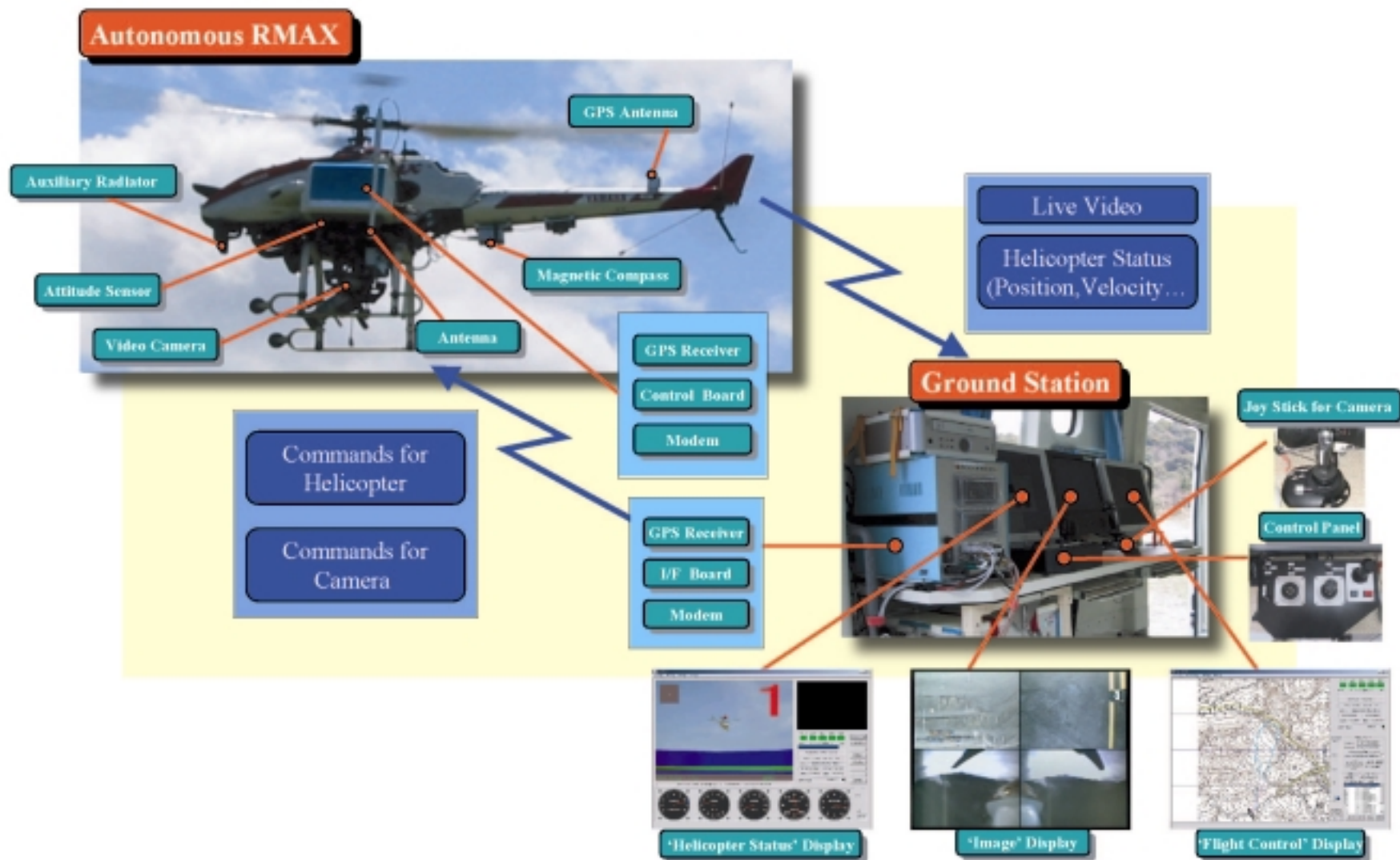
**Destroyed Houses**



**A Crater**



## Autonomous Flight Control System for YAMAHA RMAX





**YAMAHA**

## Fuji Heavy Industry RPH2 Commercial Unmanned Helicopter



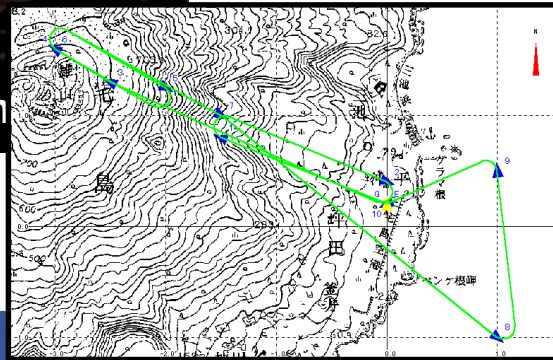
R P H 2 —Agricultural Spraying

- Gross Weight 330kg
- Rotor Diameter 4.8m



R P H 2 A —Observation

- In Service for Agricultural Spraying
- Payload up to 100kg
- Operational range < 250m
- Operational altitude < 50m



- In Service for Volcano Observing by Japan Meteorological Agency
- Autonomous Flight
- Operational range > 3km
- Ceiling > 2000m
- Endurance > 1hr





## Applications of Autonomous YAMAHA Unmanned Helicopter

### Observation of Volcanoes

April 2000 at Erupting Volcanoes Mt.Usu  
(The Ministry of Construction)



February 2000 at Miyake-jima Island  
(The Tokyo Metropolitan Government)

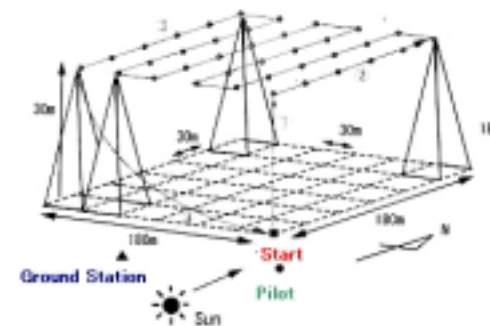
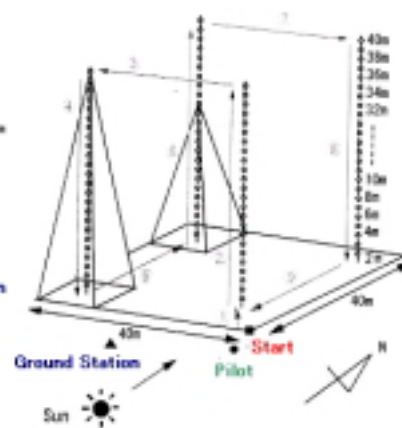
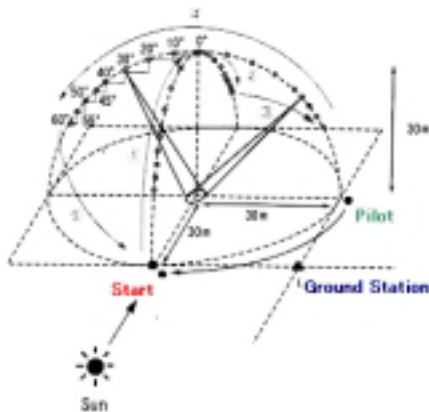




## Applications of Autonomous Unmanned Helicopter

### Observation of Plant Growth

In August 1999, the investigative observation of vegetation was performed in Mongolia.  
(The Environment Remote-Sensing Research Center of Chiba University)





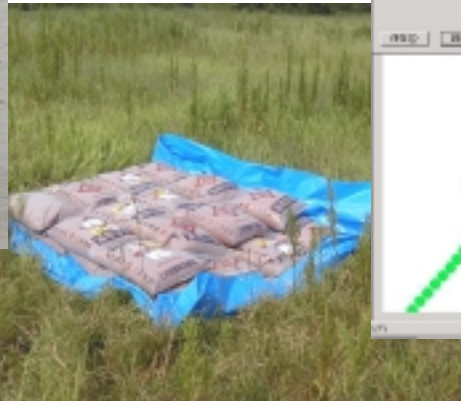
## Applications of Autonomous Unmanned Helicopter

### Radiation Monitoring for Nuclear Emergency

Japan Nuclear Cycle Development Institute and YAMAHA  
have succeeded to monitor radiation.

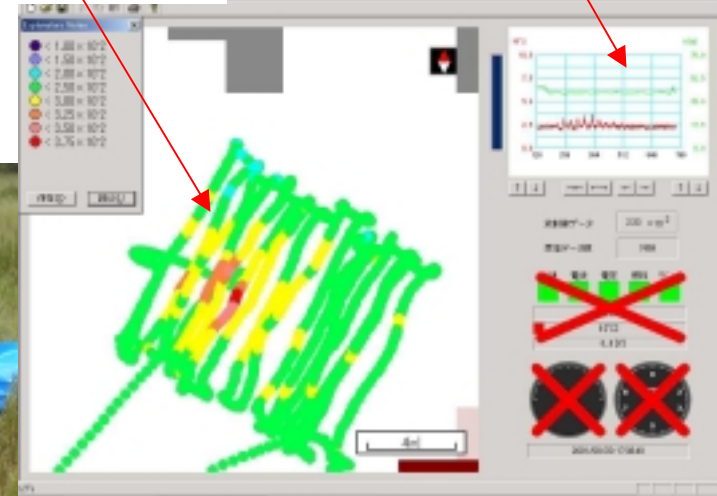


Radiation Detector



Radiation Sources  
(Agricultural chemicals containing potassium(K-40) )

Color indicator showing  
radiation levels



Variation of radiation (red)  
and altitude (green)





## *Applications of Autonomous Unmanned Helicopter*

### Inspection of damage for high-ways

The Japan Highway Public Corporation and YAMAHA have succeeded to inspect the damage of bridges and banks of high-ways.



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## *Japanese Working Group dealing with the certification*

Since April 2002, Japanese Working Group has been founded to deal with UAV-related certification and ATM issues.

### Background

- Up to date approximately 1,500 commercial unmanned helicopters have been used with in-sight control for agriculture application in Japan. ( Operational Altitude < 50 meters )
- Recent development of fully autonomous VTOL-UAVs capable of out-of-sight control extends its application into civil managed airspace. ( Operational Altitude > 150 meters )
- The absence of relevant regulations applicable to UAVs flown within the civil managed airspace is starting to be addressed by Japanese government authorities and Japanese UAV-related manufacturers.
- It activates the Japanese industry to generate a voluntary group to study such issues on a national level, not only by liaising closely with the government authorities, but also in concert with the international program aiming at internationally acceptable rules.



## *Japanese Working Group dealing with the certification*

Since April 2002, Japanese Working Group has been founded to deal with UAV-related certification and ATM issues.

### Objectives

- To develop recommendations for principal rules & regulations applicable to civil UAVs flown over Japan.
- To coordinate the international efforts relative to UAV certification & ATM issues.
- To submit consensual proposals representing the Japanese industry.
- To supply inputs to keep all the interested Japanese government authorities informed.

### Members


- Kawada Industries Inc., Fuji Heavy Industries Ltd., Yamaha Motor Co.Ltd.,  
Yanmar Helicopter Services (in alphabetical order)  
(observed by)
- Japan Ministry of Economy, Trade and Industry, (Japan Civil Aviation Bureau),  
Japan Agricultural Aviation Association.

## Proposed Categories by the Japanese Working Group

Configuration Flight Conditions		Fixed Wings	Rotor Wings	Other
<b>High Level Fault Tolerant Aircraft</b>	Flying the same area as manned aircrafts		In addition to the criteria indicated below, collision avoidance measures must be taken to prevent the unmanned helicopters from colliding with manned aircrafts.	
	Flying over inhabited area		A failsafe system, which can guide the unmanned helicopter to a safe area in the event of any type of failure, must be provided.	
<b>Standard Level Fault Tolerant Crafts</b>	Flight out of sight of uninhabited areas		Autonomous control device requirements to be added in addition to the flight criteria for the area within sight indicated below.	
	Flight within sight of uninhabited areas		Flight criteria for the altitudes between 100 to 150 meters to be added to the criteria indicated below. (This category is applied to helicopters that are flown within sight even if they are equipped with an autonomous control device.)	
	Agricultural chemical spraying application		Unmanned helicopter for spraying agricultural chemicals (base machine)	
<b>General UAV</b>	Hobby radio-controlled helicopters		Rules exist in each country around the world for radio-controlled devices	
	Micro UAV		The rules are very lenient, involving weight restrictions of several hundreds of grams and rotor protection criteria.	

Although no specifics have been set currently, the rules (of High Level Fault Tolerant Aircraft) will be studied continuously after standard Level Fault Tolerant Crafts.

Next Step



First Step





## Conclusion

### For Agricultural Use

1. Unmanned Helicopters are inevitable for Japanese Agriculture.
2. For safety, the Japanese government made certifications and a license.

### For Other Applications

1. Autonomous unmanned helicopters have been developed and they are playing observation roles at erupting volcanoes.
2. Autonomous unmanned helicopters expand their applications.

### Japanese Working Group

1. Japanese UAV manufacturers found working group to deal with UAV-related certification and ATM issues.
2. Liaising closely with the Japanese government and harmonizing with the international program.